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(54) PLATE-TYPE HEAT EXCHANGER

(71) We, PRZEDSIEBIORSTWO DOSWIADCZALNE PRZEMYSLOWYCH URZADZEN CHLODNICZYCH "COCH", of UL. Dzierzynskiego 116, Krakow, Poland, a Company organised and existing under the laws of Poland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a plate-type heat exchanger for the exchange of heat between two fluid media and suitable for operation under high pressures and at high pressure differences between the media.

There are known plate-type heat exchangers built up of flat plates of various shapes, provided with distance pieces. All the elements are rigidly fitted with each other forming a compact assembly placed in a housing provided with inlet and outlet stub pipes for the heat exchanging media flowing through the space between the plates.

There are also known plate-type heat exchangers without any housing, made of plates shaped as round, oval or square trays with rounded corners. These plates are tightly joined together along their adjacent edges, and are provided with ports and passage stub pipes enabling the heat exchanging media to flow between said plates, each of said media flowing through every other interplate space.

A disadvantage of known plate-type heat exchangers consists in that they can be employed only in heat exchange processes where the pressures of said media are not considerable. High working pressures cause buckling of the plate elements, and leakages of welded or glued joints. This limits considerably the use of said exchangers for working under high thermal and mechanical loads. To counteract this unfavourable behaviour by increasing the thickness of plates and jackets, or employing stiffenings, leads to an increase of the weight of the exchanger, which is economically undesirable.

An object of the present invention is to provide a design of the heat exchanger showing the energetic advantages of plate-type exchangers, and the high strength of jacket-and-pipe exchangers, and offering the possibility of easy changing of the heat exchage area.

According to the invention we provide a plate-type heat exchanger for exchanging heat between two fluid media, which exchanger is composed of a plate assembly in which the plates are connected fluid-tightly with one another and form two parallel ducts flowed through by the heat exchanging media, which assembly is enclosed in a fluid-tight jacket with an internal space, one of the ducts formed between the plates of the assembly being connected at one end with the internal space of the jacket.

The plate assembly is preferably composed of two types of plates symmetrical about two mutually perpendicular respective axes, arranged alternately and each provided with two through-openings, one of which is fitted with a neck. Said through-openings in both types of plates are located offset from the main axes of the plates at equal distances from the centres of the plates, and the angles between radii, on which the axes of openings of neighbouring plates are positioned, are different, the sum thereof however being equal to 180°.

Each type of plates carries, on its surface, distance pieces, arranged on diameters not covering mutually.

The advantage of the exchanger according to the invention is its simple and compact structure and favourable energetic characteristics. The plates of the heat exchanger are unified thus can be manufactured by means of a single device. Moreover, according to the requirements, the plates may be assembled in a set having a determined heat exchange area.

The fact that one flow-through duct within the plate assembly leads to the internal space of the jacket makes it possible to eliminate pressure loading on said assembly completely or partially. In the case of equal pressures of the heat exchanging media the plate assembly is free of pressure loading.

The reduction or elimination of pressure load acting on the plates permits operation of the heat exchanger under high working pressures limited only by the strength of the outer jacket

The plate assembly has very low thermal inertia, which is of importance in the case of processes with automatic regulation.

An exemplary embodiment of the invention is explained with reference to the accompanying drawings, wherein:—

Figure 1 is a longitudinal sectional view of a heat exchanger on line A—A in Figure 2;

Figure 2 is a cross-sectional view on line B—B in Figure 1;

Figure 3 is a plan view of one type of plate of the heat exchanger;

Figure 4 is a cross-sectional view on line C—C in Figure 3; and

Figure 5 is a plan view of the other type of plate of the exchanger.

The exchanger is composed of a jacket 1 closed at one end by a flanked flat plate 2, and at the other end by a dished plate 3. Within the jacket 1 a plate assembly 4 is mounted on supports 5 welded to the plate 3.

The plate assembly 4 is composed of alternately arranged plates 6 (Figures 3 and 4) and 7 (Figure 5). Said plates are in the shape of round trays each with a frusto-conical flange 6A and are provided with two through-openings each, namely an opening 8 without a neck, and an opening 9 provided with a neck 10. Said through-openings are offset from the main axes of the plates 6 and 7 and are at equal distances from the plate centres.

The angles between radii, on which the axes of the opening 8 and 9 of consecutive plates 6 and 7 are located, are different but their sum on two adjacent plates 6, 7 equals 180°.

The plates 6 and 7 are mounted together in the following way (looking onto the lower plates after Figure 1):— The opening 8 of the plate 6 is connected with the inlet stub pipe 20 of the medium *b*. The opening 8 of plate 7 is fitted over the neck 10 of the plate 6. The opening 9 of the plate 7, provided with the neck 10, is inserted into the opening 8 (not shown in the drawing) of the plate 6 next above, the opening 9 of the latter plate 6, provided with the neck 10, is connected with the opening 8 of the plate 7 next above, and so on. Thus the plates 6 and 7 alternate. Successive plates 6 are turned in the plane of the plate relative to each other by 180°, and successive plates 7 are also turned in the plane of the plate relative to each other by 180°

The plates 6 and 7 are fluid-tightly welded with one another along their borders and at the contact edges of the openings 8 with the necks 10. At the ends of the plate assembly 4 flat plates 12 and 13 are welded on as well as reinforcing rings 14 and 15 to which flexible spacing elements 11 are fixed. The latter are in the form of strips or slats and interconnect the end plates 12, 13. Their function is to ensure proper assembly of the plates and to isolate the inlet and outlet pipes 17, 18, 20 from lateral displacements of the plate assembly.

The plates 6 and 7 are provided with extruded conical spacing elements 16 with the high equal to the spacing of said plates within the assembly 4. Said elements 16 are arranged on diameters not covering by one another.

Thus the plate assembly 4 defines two separate parallel ducts for flow of the media *a* and *b*, the duct for whereby the one thereof is from one end medium *a* being connected with the internal space of the jacket 1.

The heat exchanger is provided with connector pipes 17, 18, 19 and 20 serving as inlets and outlets for the media *a* and *b*. Pipes 17, 18, 20 communicate directly with the plate assembly whereas pipe 19 communicates with the internal space of the jacket.

The heat exchanging media flow through the plate assembly 4 in the following way (Figure 1):— the medium *b* supplied through the connector pipe 20 flows along the lowest plate 6 to the opening 9 (not shown in Figure 1) of the plate 7 next above, and flows through the neck 10 of this plate 7 into the next plate 6, therefrom through the opening 9 with neck 10 of the next plate 7 into the subsequent plate 6, and so on to the outlet connector 17.

Similarly, the medium *a* flows through the plate 7 from connector 18 to connector 19 and simultaneously fills the space between the assembly 4 and the jacket 1.

Owing to the spacing elements 16 in the plates 6 and 7 the flow of the media *a* and *b* becomes turbulent, which increases the rate of heat exchange. This process gets intensified additionally owing to the arrangement of through-openings 8 and 9 in the plates 6 7, which forces the media *a* and *b* to flow along the surface of said plates.

The maximum pressure acting on the plates of the plate assembly 4 equals the pressure difference of media *a* and *b*, outside this assembly, however, the pressure of medium *a* is present. If the pressures of media *a* and *b* are equal, the plate assembly 4 is released completely from pressure loading.

The heat exchanger can operate with media of various viscosities and at a wide range of working pressures.

The heat exchanger can operate in horizontal or in vertical position.

WHAT WE CLAIM IS:—

1. A plate-type heat exchanger for ex-

changing heat between two fluid media, which exchanger is composed of a plate assembly in which the plates are connected fluid-tightly with one another and form two parallel ducts flowed through by the heat exchanging media, which assembly is enclosed in a fluid-tight jacket with an internal space, one of the ducts formed between the plates of the assembly being connected at one end with the internal space of the jacket.

2. A heat exchanger according to claim 1, in which the plate assembly is built up from two types of plates respectively symmetrical about two mutually perpendicular axes and arranged alternately, each plate being provided with two through-openings one of which is provided with a neck, said opening in both types of plates being offset from the main axes of the plates but at equal distance from the plate centre, and the angles between radii on which the axes of said openings on neighbouring plates are situated being different and equal in sum to 180°.

3. A heat exchanger according to claim 2, in which the plates have on their surfaces spacing elements positioned on mutually not covering diameters on every one plate.

4. A heat exchanger substantially as herein described with reference to the accompanying drawings.

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Sheet 1

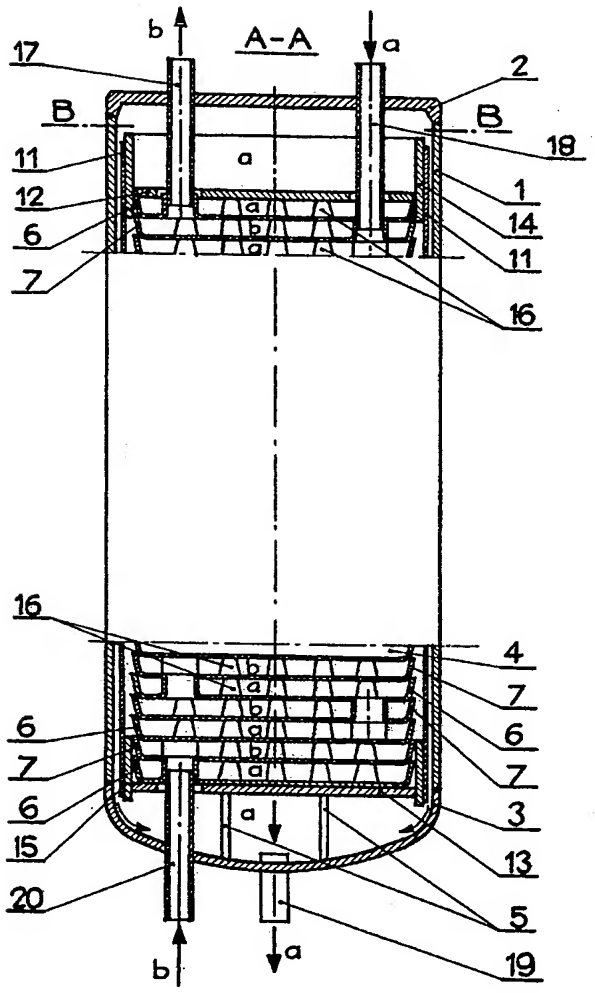

Fig.1

1405976 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

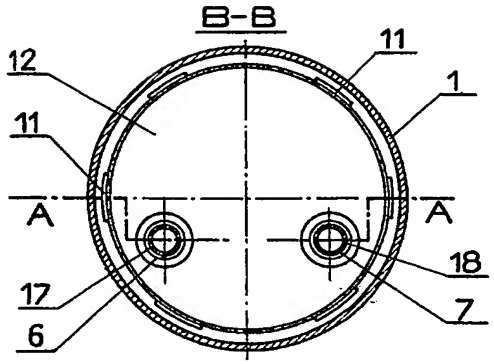

Fig. 2

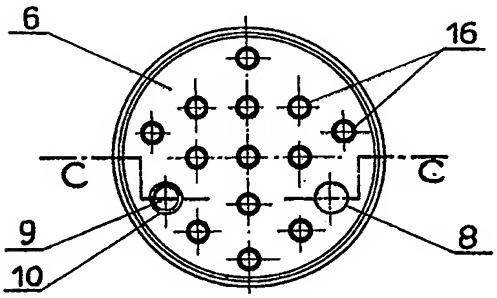

Fig.3

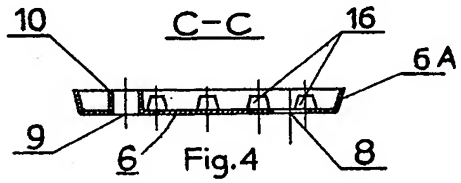

Fig.4

1405976 COMPLETE SPECIFICATION
3 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 3

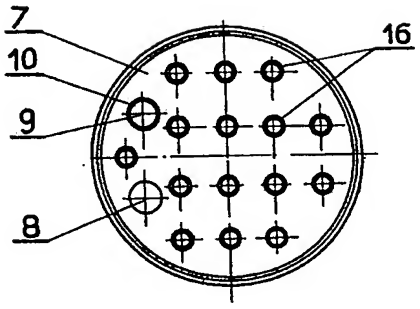

Fig. 5